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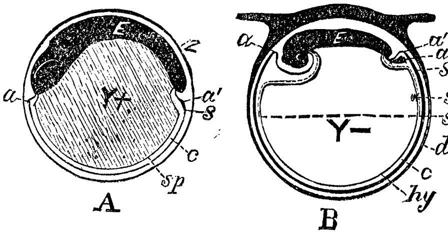
Mammals.—Mr. Sidebotham (Proc. Zoöl. Soc. London, 1885) gives a detailed account of the myology of the water opossum, *Chironectes variegatus.*——The discovery of the wild cat (*Felis catus*) in Ireland, is often reported, but investigation has always shown that the supposed wild cat was but a feral specimen of the domestic cat.——A leopard skin in which most of the rosettes are replaced by black spots, numerous and of small size, has been brought from South Africa, and is the first African species which exhibits the tendency to melanism so strongly developed in some Asiatic individuals.——Mr. O. Thomas (P. Z. S. 1885, 329), distinguishes three varieties of the echidna, viz: *E. lawesi, aculeata* and *setosa.* The only remaining recent species of the family is *Taglossa bruijni*, a larger animal, found in Northwestern New Guinea.——A new species of paca (*Cœlogenys taczonowski*) is described by Sulzmann, who obtained it in Western Ecuador, where it inhabits mountains between 6000 and 10,000 feet above the sea. Like the well-known paca, it digs a burrow with two openings. The native name is Sacha-cui.

EMBRYOLOGY.[1]

THE ORIGIN OF THE AMNION.—The purpose of the present note is to point out some of the mechanical conditions and causes which have been competent, in the course of the *development of development*, to bring about the formation of the amnion. No embryological writer, as far as I am aware, has ever attempted to trace the amnion to the part in the embryos of anamniated forms which led up to its development in the amniated ones. Balfour said, that "it does not seem possible to derive it from any preexisting organ" (Comp. Embryol., II, 256). And he says further (op. cit., 257): "The main difficulty is the early development of the head-fold of the amnion." Balfour's view, that it is developed *pari passu* with the outgrowth of the allantois, is utterly inadequate to explain the genesis of the amnion of insects or that of *Peripatus edwardsii* and *P. torquatus*, for in them no allantois is formed. His hypothesis also breaks down in the light of the brilliant researches of Selenka on the inversion of the layers in the Rodentia.

A comparison of the longitudinal, vertical, diagrammatic sections, figures *A* and *B*, of an osseous fish-egg and a mammalian ovum respectively, will conclusively show that the somatopleure *s*, in *A*, is the exact homologue of the layer giving rise to the amniotic folds in *B*, though in *A* this layer merely covers the space



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[1] Edited by JOHN A. RYDER, Smithsonian Institution, Washington, D. C.

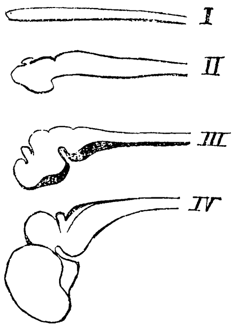
between the yolk *y* and the somatopleure, leaving the cœlomic space *c*, which has been derived directly in the osseous fish embryo from the cleavage cavity of the egg. We thus find that the preëxisting structure, from which the amniotic folds are formed in the higher types, is already present in the embryos of osseous fishes. The next important point to demonstrate is, at what grade in the phylum of the Chordata traces of amniotic folds first appear, and whether such rudiments of an amnion are also found in the embryos of osseous fishes.

Glancing at *A*, it will be seen that there are rudimentary amniotic head and tail folds developed at *a* and *a'*, and that we, therefore, have traces of an amnion appearing for the first time in embryos of the grade of osseous fishes. This is not universal, however, for it is found that in species in which the zona radiata *z* does not closely invest the ovum, the embryo *E* is not pressed down into the vitellus, so as to raise the somatopleure *s* into a fold or duplicature around the ends and along the sides of the embryo. The zona invests the ovum more or less closely in almost all Teleosts, but in a few, Alosa, for example, it does not, and in this species no traces of amniotic folds are ever developed.

The embryo is differently conditioned in those eggs with the zona fitting closely around the ovum from those in which there is a great space around the egg, and between the latter and the zona. The inference, therefore, is that in the first case the embryo *E* is pressed down mechanically into the yolk by the presence externally of the rigid zona. As the embryo *E* grows, and the yolk substance of the ovum is converted into it, the latter is replaced in the space within the zona by the embryo. It is thus rendered evident, that, in those types of teleostean ova with a closely fitting zona, the rudimentary amniotic folds which are formed around the embryo have been mechanically caused by the rigid zona in the presence of the active forces of growth. If we examine the mechanical conditions under which the eggs of still higher forms are placed, we will find the same reasoning to hold. We are thus, it seems, obliged to conclude that the amnion in all forms has arisen in consequence of the forces of growth resident in the embryo, encountering peripheral and external resistance either in the form of a rigid outer egg-shell, zona radiata *z*, or decidua reflexa *dr*, or even the walls of the uterine cavity itself, supposing, of course, that a large vesicular blastoderm containing yolk has been formed by epiboly.

The gap between the truly epicyemate embryo, as seen in Alosa, and the endocyemate embryo of the Paratheria and Eutheria is, therefore, partly bridged by the presence of a rudimentary amnion, or amniotic folds in many teleostean embryos just prior to their escape from the eggs, or where the zona is ruptured. When this occurs the amniotic folds vanish, as in the embryos of many of the Salmonidæ, for example, and a closed amniotic sack is never formed, because, in the first place, the intra-oval period of development does not last long enough; nor,in the second place, is it possible, owing to the comparative small size of the yolk, and the rapid growth of the embryo, for the latter to become bodily invaginated into the blastodermic vesicle, which is filled with yolk. The amniotic folds can, therefore, not meet upon the middle line of the back, and coalesce, as they do in the higher endocyemate forms. The development of a transient amniotic head-fold of greater width and in advance of the side and tail folds, is also prevented by the absence of a strongly marked cranial flexure in the embryos of Teleosts.

The mechanical effect of the gradual development of the cranial flexure in exaggerating the development of the amniotic head-fold in the Chordata, will be best appreciated by a glance at diagrams I, II, III, and IV, representing respectively the brain of an acraniate, a marsipobranch, an elasmobranch and a mammal. With the increase in the volume and area of the cerebral cortex, which occurs mainly on the dorsal and lateral aspects of the anterior end of the neurula, the acceleration of growth of the brain substance also occurs on those aspects, and a downward flexure of the floor of the brain necessarily takes place. The rapid enlargement of the cephalic end of the embryo of an endocyemate, eutherian or paratherian form, and the rapid or precocious development of the cranial flexure, would naturally, in such a type, tend to cause the amniotic head-fold to be developed earlier and to a greater extent than the tail-fold, as is shown in Fig. *B*, at *a*.



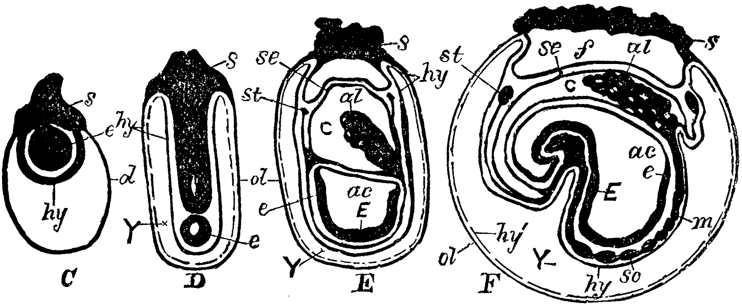
In the eutherian types, with inverted germinal layers, an amniotic head-fold of the kind developed in normal forms is never formed, because the cavity of the true amnion in the former is developed by the vacuolization or the formation of a cavity or cavities in the solid epiblastic mass, and not by invagination. In the Tracheates possessing an amnion there is no cephalic flexure, and the part of the amnion which is first developed in the most pronounced manner is often the tail-fold, due apparently to the ingrowth of the caudal end of the embryo into an involution of the blastoderm, confined in a rigid egg-envelope, the involution being thrust into the yolk. Later, with the growth and encroachment of the head-end of the embryo upon the yolk, the abdomen is again everted in some cases from its amniotic sack. In *Peripatus edwardsii*, according to Von Kennel, cleavage is total, the development is viviparous and intra-uterine, a hollow blastula is formed, the embryonic area at one pole of the blastula is invaginated into the latter, so that the ventral surface of the embryo is directed towards the roof of the amniotic cavity, the reverse of the eutherian embryo. An umbilical stalk is also formed, which springs from the dorsal surface of the embryo and passes to a partially zonary placenta, disposed in relation to the uterine walls in exactly the same way as that seen in the embryo of Carnivora. If we now regard the dorsal surface of the embryo of *Peripatus edwardsii* as homologous with the ventral surface of the embryos of Carnivora, the resemblance between the modes of development of these two types becomes still more startling. While it is manifestly absurd to even attempt to suppose, on the strength of these resemblances, that there could be any genetic affiliation between the Carnivora and Malacopoda, the only way out of the difficulty seems to be to suppose that the similar methods of development of the two arose in response to the similar conditions which environ the ovum during its early stages of growth.

The differences between Von Kennel and Sedgwick, as to the modes of development of *P. edwardsii* and *P. capensis*, it seems to me, may be readily understood and reconciled when it is considered that the first is holoblastic and endocyemate, while in the latter the egg is meroblastic, and apparently undergoes an epicyemate process of development.

All the data in the foregoing paragraphs unequivocally support the thesis that the amnion has been developed mainly by mechanical means and conditions.

The rigid zona of the epicyemate teleostean embryo, as shown in Fig. *A*, in which the yolk *y* is a positive quantity, is represented by the maternal envelope *dr* in Fig. *B*, in which the yolk, as such, is absent. The gap between the condition of *A* and that of the types with apparently inverted germinal layers, so completely elucidated by Selenka, is a wide one; yet it seems easy to pass from the primitive condition of *A* to that of the extremest form, viz., the guinea-pig; if the rabbit, mole (Heape), the vole (Kupffer), and the mouse and rat (Selenka), are considered as intermediary steps. So complete or extreme has been the invagination of the embryonic mass or area in these forms that, in the extremest type, the embryo is finally developed at that side or pole of the primitive blastula which is exactly opposite the point where the blastodisk was originally formed, as in normal Eutheria. The way in which this is accomplished is quite remarkable, and may now be described, as the process is a special modification of that by means of which the usual endocyemate condition is brought about.

Selenka finds that there is an outer layer of cells, *ol*, Fig. *C*, split off from the ectoblast, as first described by Rauber, in the rabbit's ovum, and which take no direct part in the formation of the embryo. He also finds that upon the further growth of the ovum, after the blastula stage is reached and the germinal area or disk is developed, the blastula rapidly elongates in the direction of the diameter extending from the centre of the blastodisk to the opposite pole. By this time the blastula has become



adherent to the uterine epithelium through the intermediation of the transitory outer layer of cells, *oi* (*Reichert'sche Deckschicht*), already mentioned, but the constituent cells of a certain portion of this outer layer, just overlying the germinal disk, as indicated at *s*, rapidly proliferate, so as to form a lenticular or columnar thickening or mass, constituting what Selenka calls the *Träger*, a term which may be anglicized by the word *suspensor*. This suspensor immediately overlies and pushes the germinal area or mass inwards before it, down into the hollow cavity of the blastula. The germinal area is either pressed inwards into the hollow blastula, so that it assumes a concave form above, with a cavity between it and the lower surface of the suspensor, as in Arvicola, or the epiblast forms a solid mass, before which the hypoblast is pushed inwards by the ingrowth of the suspensor, so that the blastula assumes the form of an elongated sack, as in the ovum of the rat or the guinea-pig.

The process just described is somewhat similar to that of gastrulation, for the germinal pole of the blastula is pushed downward into the sack formed by the hypoblast and outer layer, so that the embryo is finally developed quite at the opposite pole of the elongated blastula, as in the guinea-pig. The steps by which the mode of development of the embryo of the latter came to be established will be much better understood by reference to diagrams *C*, *D*, *E*, and *F*, representing four stages of the development of the rat copied from Selenka.[1] In these figures it will be obvious to the reader that the principal result of the precocious invagination of the embryonic area is to throw the embryo to the opposite pole of the egg, and to so encroach upon the cavity of the mesenteron, the umbilical vesicle, as to almost obliterate it, as is shown in Fig. *F*. The embryo *E* is also bent into a curve, just the reverse of that shown in Fig. *B*. The cœlomic space *c* is also more restricted, and the sinus terminalis *st*, in Fig. *F*, seems to terminate towards the dorsal pole of the ovum instead of the ventral, as in Fig. *B*.

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[1] Studien über Entwickelungsgeschichte der Thiere. Drittes Heft. Die Blätterumkehrung im Ei der Nagethiere, 4to. Wiesbaden, Kreidel, 1884.

In the ovum of the guinea-pig the obliteration of the umbilical vesicle *y* is carried still farther than in Fig. *F*, because the hypoblastic layer *hy'*, next to the layer *ol*, is absent, and the hypoblast lying just under the embryo is brought into immediate contact with the layer *ol*, thus giving rise to the illusion that a complete inversion of the primary embryonic layers has occurred. I say illusion, because there has been no actual inversion of the primary layers, for the latter have been merely shoved to the opposite pole of the eggs into contact with the layer *ol*, where embryonic development has proceeded in the normal way, being modified only by the displacement which the germinal area has suffered in relation to the other essential parts of the ovum. It is as if the germinal pole of the blastodermic vesicle had become concave instead of convex, and collapsed inwards against the inside of its lower pole, the walls of which consist of the hypoblast of the inferior pole of the umbilical vesicle—mesenteron, and the outer layer.

The difficulties which Balfour speaks of have, I hope, been satisfactorily cleared away by what has been said above, and a rational and connected hypothesis as to the genesis of the amnion firmly established. I am aware that many objections may be urged against the views here propounded, but I cannot think that any other view of the case will so satisfactorily reconcile and coördinate the facts involved. To those who take a philosophical view of such subjects, it will be obvious that the deductions here reached give but little countenance to the idea that amniotic characters can be always profitably used in taxonomy, at least, not until the forces which have led to their development are better understood. On the theory of the development of development, the extreme modification of the amnion of some of the Rodentia would cause the latter to take higher rank than the Primates, because, as shown in Fig. *F*, the primary amniotic cavity becomes divided, and a relatively large false amniotic cavity *f* remains just under the suspensor *s*, and shut off from the true amniotic cavity *ac* by the intervening serous envelope *se*, the cœlomic space *c*, and the somatopleural roof of *ac*. Such reasoning, however, is obviously not legitimate in the light of the above mechanical hypothesis of the genesis of the amnion.

To briefly summarize, we find that the first traces of amniotic folds met with in the embryos of the lower types of Chordata are caused by the resistance from without offered to the growth of the embryo by a rigid zona radiata. In such types the amniotic folds are transitory, and disappear at the time the zona is ruptured. After a larger yolk has been acquired the embryo undergoes a longer period of intra-oval development, so that the period of the persistence of the amniotic folds, produced as before, is prolonged.

With the increase in the size of the embryo, in these large-yolked forms, it is finally thrust down into a saccular involution of the blastoderm, the lips of the opening of which meet over the back of the embryo where they coalesce, the outer limb of the duplicature giving rise eventually to the serous envelope, and the inner to the roof of the amniotic cavity. In those types which have the primary layers apparently inverted, the rapid ingrowth of the suspensor precociously invaginates the germinal area inwards before the embryo is distinctly developed, so that it is not formed in its usual or normal position. These extreme modifications were not possible until after the loss of the food-yolk, after which a hollow blastodermic vesicle still continued to develop, filled with a thin albuminous or serous fluid instead of a dense yolk material. The tendency of the eutherian ovum to form a large, hollow blastodermic vesicle or blastula is doubtless an inheritance transmitted from a paratherian source. The bodily invagination of the whole embryo, and the more or less complete obliteration of the cavity of the umbilical vesicle by the rapid growth of the enlarging amnion, would be readily accomplished in the course of the development of the eutherian ovum.

EXPLANATIONS OF THE REFERENCE LETTERS USED IN THE FIGURES.

a amniotic head-fold, *a′* tail-fold, *ac* amniotic cavity, *al* allantois, *c* cœlomic space or continuation of body cavity, *dr* decidua reflexa of uterus, *E* embryo, *e* epiblast, *f* cavity of false amnion (*falsche amnionhöhle*), *hy* hypoblast, *hy′* hypoblastic outer wall of umbilical vesicle, *m* mesoblast, *ol* outer layer (*Reichert'sche Deckzellen, Deckschicht*), *s* suspensor (*Träger*), *se* serous envelope, *so* muscular somites, *sp* splanchnopleure (= the periblast in Fig. *A*), *st* sinus terminalis, *Y* yolk, with + and — signs to indicate its presence or absence.

—*John A. Ryder.*

DECEMBER 31, 1885.

PHYSIOLOGY.[1]

THE EXISTENCE OF TWO KINDS OF SENSIBILITY TOWARD LIGHT. —MM. Charpentier and Parinaud, working independently, have concluded that visual sensations involve two distinct kinds of physiological processes. Sensations of one kind are "photesthetic" and involve luminous sensations pure and simple, merely discriminating light in distinction to darkness. The other sensations are truly "visual" and are necessary to the perception of color, of form, and to distinctness of vision. The first kind of sensation is supplied by the excitement of the rods of the retina through the chemical disintegration of the "visual purple," which is found in their outer segments. The power of giving rise to the second kind of sensations is confined to the retinal cones which wholly compose the bacillary layer of the fovea centralis, but which relatively decrease in number with reference to the rods as we recede from this area. Parinaud declares that the increase of sensibility of the retina to small differences of luminosity when the amount of objective light is extremely small is confined

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[1] This department is edited by Professor HENRY SEWALL, of Ann Arbor, Michigan.